Motivation for an IT Framework Architecture for the Implementation of the European Water Framework Directive

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The implementation of the European Water Framework Directive (WFD) is not only an ambitious task from the thematic point of view, but also from the perspective of the required support by information technology (IT). While the WFD itself does not include concrete IT recommendations, e.g., for data storage, exchange, map or report formats, regional and/or national environmental agencies have to build or adapt their information systems now in order to deliver the results for the first WFD reporting phase in time. Moreover, as the WFD requires a water management policy based around natural river basin districts instead of administrative and political borders and demands co-ordinated "programmes of measures", the agencies have to co-ordinate their work and combine their results with other agencies, possibly across national borders. On this background, the present article motivates the need to develop an IT Framework Architecture for the WFD implementation.

1. Introduction

1.1. The European Water Framework Directive

The Water Framework Directive (WFD) is widely recognised as one of the most ambitious and comprehensive pieces of European environmental legislation to date (EU 2000). Its aim is to ensure that all European waters are protected according to a common standard. The Directive has two key components:

- a system of management of the natural water environment based around natural river basin districts (instead of administrative and political borders); and
- the introduction of co-ordinated "programmes of measures" with the ultimate objective of achieving (at least) "good status" for most of the European rivers, coastal waters and underground waters by 2015.

River basin management according to the WFD is a multi-step process. The first step, to be concluded by 2004, is to assess within each river basin district the ecological status of rivers, lakes and groundwater. For groundwater, the key factors are chemical contamination and quantity, for surface water it is the quality of the structure and functioning of aquatic ecosystems as well as the chemical surface water status as a measure of pollution. The results of this phase are to be reported to the European Union after having being assembled on river basin level.

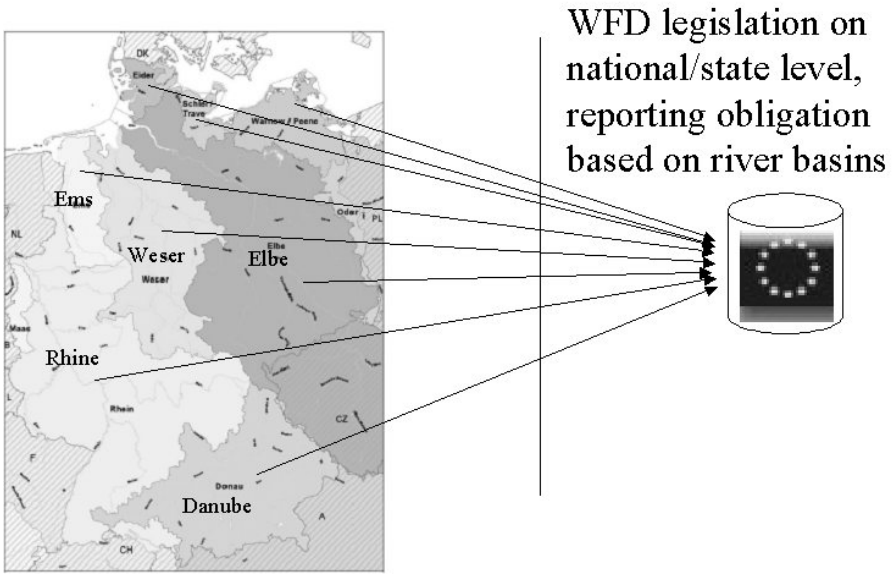


Figure 1: WFD Reporting Obligations

On the basis of installed monitoring programmes by 2006, objectives will then be set for each water body and measures will be put in place to achieve these objectives by 2009. The water body status will then be re-assessed to determine whether the specified objective has been met. This process will be repeated on a continuing basis.

1.2. IT Viewpoint

The WFD is not only a fundamental rethink of the EU water policy, its implementation is also a challenge for the supporting information technology (IT) and, especially, for a WFD-specific information management.

At a first glance, when just regarding the information flow for the reporting in figure 1, the task looks quite simple. However, at a closer look, and also when considering the existing organisational and IT pre-requisites, it is getting quite obvious that already the initial reporting task is quite complex and expensive (see figure 2):

- The raw data has to be sampled from monitoring points for ground and surface water, either automatically or, still very often, manually. While quantitative data (e.g. groundwater and surface water levels) can directly be stored in files and/or databases, qualitative data has to be gained through analysis procedures in water laboratories and then reported to the respective environmental agencies on urban, regional or state level. It is important

to mention that both the detailed workflow and the data formats are in no way standardised or harmonised beyond and across the administrative or political boundaries.

- Further on, the data gained from a multitude of sources has to be combined with other spatial information, interpreted, aggregated and evaluated in order to provide the condensed information required. This usually still happens on an administrative level that does not consider river sub-basins or even river-basins.
- In order to reach the river basin level as required by the WFD, administrative or even national borders have to be overcome and an intense co-operation between environmental agencies is required in order to provide the final report to the European Commission for the river basin.

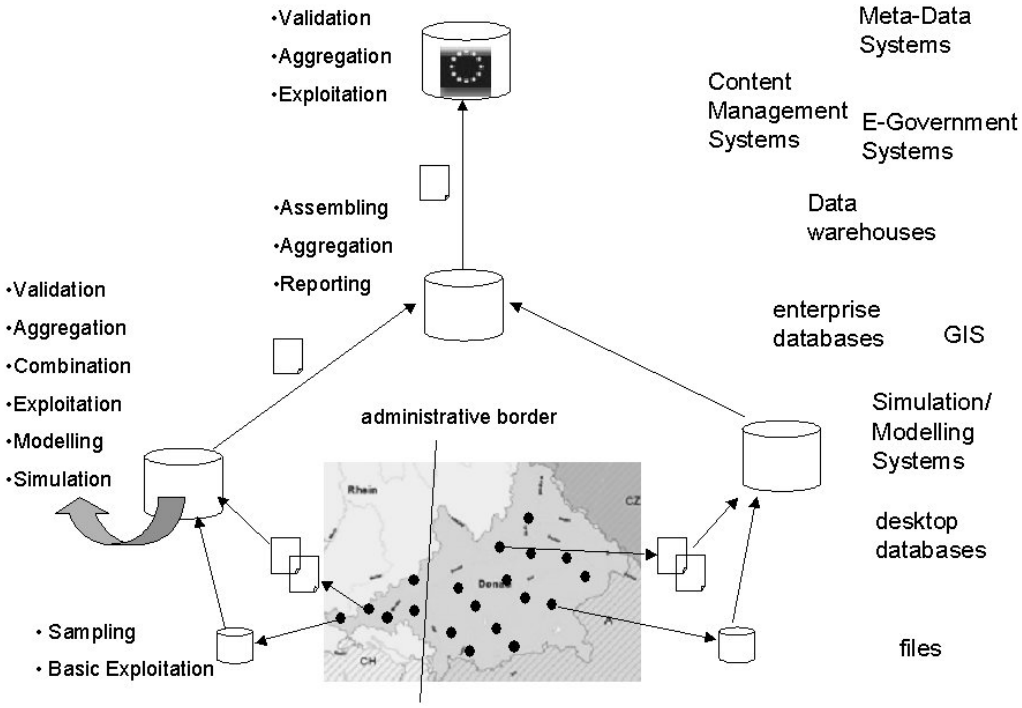


Figure 2: WFD Reporting Levels

1.3. IT Systems Involved

It is obvious that no single IT system may fulfil all the requirements for the implementation of the WFD. However, seen from a broad perspective, there are consequences for IT systems in two functional layers (see figure 3):

1. the thematic layer
2. the co-operation layer

In the thematic layer, the most challenging subject is the integration or at least the coupling of the existing IT systems and data both for the surface water and the groundwater domain, possibly with additional information on water and nature protection areas, soil and waste and land use. Here, a multitude of legacy systems has to be migrated into an integrated thematic information system with a common approach for the meta-, master and measurement as well as the spatial data. It will then be possible to carry out integrated assessment and analysis on both groundwater and surface water data based on (partial) river basins, visualise them together in thematic maps and diagrams and generate common reports according to the requirements of the Directive. Modelling, simulation and visualisation tools in the thematic layer are needed to prepare and support the decisions that have to be taken for integrated water management on regional (e.g. sub-river basin) level.

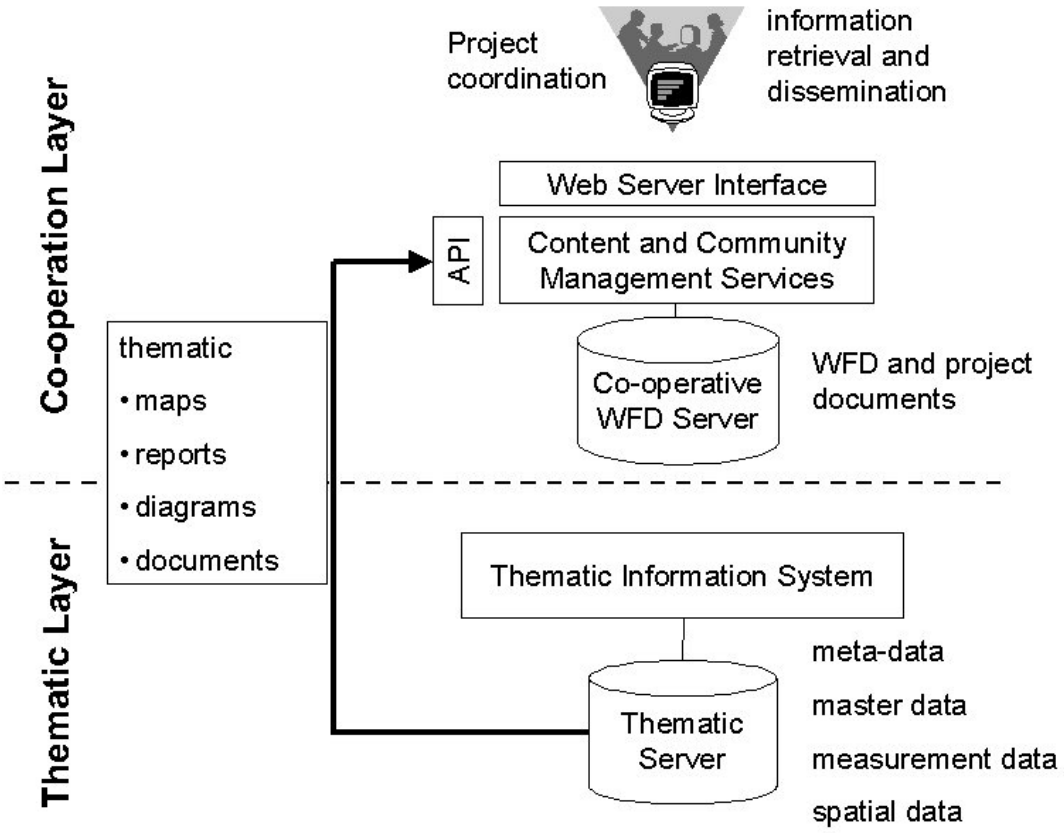


Figure 3: Layered Information System Architecture

IT systems in the co-operation layer have two main objectives:

1. They should efficiently support the co-ordination of WFD projects and the management of the community that is involved in the implementation of the Directive. Typically, this community is very heterogeneous. Its members are thematic experts, located at different sites and mostly belonging to different agencies and companies. Thus, the respective IT system must support co-operation with techniques familiar to office environments without requiring programming knowledge.

2. IT systems in the co-operation layer must be able to import, receive, visualise and store the results coming from the thematic layer in form of thematic maps, river basin status documents or reports in tabular or textual formats. Furthermore, this information has to be combined and aggregated to a higher degree and again put into a reporting format.

IT systems in the co-operation layer mainly consist of a combination of spatial data warehouses with content and community management systems. As the WFD requires the involvement of the public when discussing programmes of measure, these systems will also have to provide functions of e-Government systems in the future.

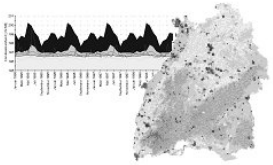
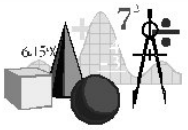
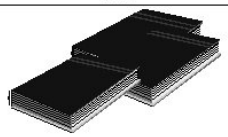
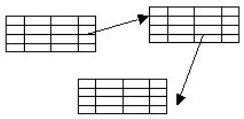
Decision-making	decision-support modelling/simulation prediction	
Presentation	thematic maps thematic diagrams thematic reports	
Statistics	aggregated measurement values percentiles interpolation	
Grouping/Views	folders of measurement locations list of parameters export filters selectors of measurement data	
Data Storage	master data of wells/intakes measurement data addresses object relationships user-defined objects	

Figure 4: Information processing levels of the WAABIS module Groundwater

2. Examples of Layer-specific IT Solutions

In the following, two examples for layer-specific IT solutions are shortly described. For a more specific description, see [EnviroInfo02].

2.1. The Environmental Information System WAABIS

The integrated information system WAABIS (Mayer-Föll 2001) for water, waste, contamination and soil that has been commissioned and is operated by the Ministerium für Umwelt und Verkehr[1] (UVM) and the Landesanstalt für Umweltschutz[2] (LfU) in Baden-Württemberg, Ger-

[1] Ministry for Environment and Transport Baden-Württemberg

[2] State Institute for Environmental Protection Baden-Württemberg

many is one example of an open and flexible IT system in the thematic layer. WAABIS is an operational example of the service approach of the overall Environmental Information System (EIS) concept of Baden-Württemberg.

The WAABIS module Groundwater provides a tailored view of the inventory of the groundwater resources in Baden-Württemberg (Usländer 2002). It comprises a detailed recording of the thousands of wells and intakes with a description of their construction and associated hydrogeological information as well as millions of measurement values for both groundwater level and chemical quality. The module provides support for all levels of information processing as described in figure 4. It has been in use since 1999 by environmental agencies, water control bodies as well as urban and rural districts of Baden-Württemberg. In an co-operation with the state of Thuringia, the system is being extended towards an integrated view of both surface and groundwater resources as required by the river basin approach of the Directive (TMLNU 2002).

2.2. WebGenesis for the Co-operation Layer

The co-operation layer for the support of the WFD implementation requires powerful tools to manage collaborative work and easy-to-use but controlled presentation and publication of results. Here, a Web-based content and community management system seems to be the best technical solution. WebGenesis, the IT platform for generating and supporting Web-based information systems (Bonn 2001), provides all typical features of a content and community management system with a focus on

- information categories such as folders, documents, discussion forums or directories,
- generated layout for a consistent representation of meta-data,
- complex (full text) search mechanisms on meta-data and content,
- automatic generation of navigation facilities,
- authoring support (e.g. different levels of functionality by using online forms for interactive information acquisition and creation),
- assignment of graduated access rights to users and user groups by the authors themselves, inheritance and management of access rights by means of the folder hierarchy
- community tools (e.g. forums, addresses, calendars, shops, literature lists)
- recovery points (milestones, archives)
- knowledge management by ontologies to describe potential relationships between instances of two information categories,
- a variety of functions to administrate user groups, users, access rights and system configuration.

In Germany, WebGenesis is already in use in the context of the Directive: at national level, it is the foundation of the central WFD co-operation server for the implementation of the Directive (e.g. see <http://wasserblick.net/start.html, 2003/02/27>, at State level, e.g. in Hessen and Rheinland-Pfalz, it supports various WFD-related (pilot) projects.

2.3. Layer Integration

In order to efficiently master the information flow between the thematic layer and the co-operation layer, the WAABIS module Groundwater has been extended by an upload mechanism that can directly connect to a WebGenesis installation over an Intranet or the Internet. Thematic

documents such as maps, reports or diagrams as working results in the thematic layer, can then easily be published on a co-operative WFD server under the assumption that adequate access rights have been configured by the administrator of the WFD server. By using the template approach of WebGenesis, the documents are integrated in HTML-based Web pages with controlled visibility and access rights. A common look-and-feel for all providers of information on a river basin district or part thereof may easily be achieved.

3. European Initiatives towards a common WFD implementation

The workflow examples when just considering the reporting phase of the WFD already show that there is a huge need for harmonisation and possibly standardisation when aiming at an efficient implementation of the WFD within Europe. The need is even higher when considering that the WFD reporting obligations have also to be fulfilled by EU members or future member states where the environmental information infrastructure may have to be built from scratch with limited financial resources.

Having this in mind, the European Commission has set up a WFD Common Implementation Strategy. In this context, a series of mostly thematic working groups and joint activities have been launched for the development and testing of non-legally binding guidance. From the IT point of view, the working group Geographical Information System (GIS) is the most relevant one as it goes far beyond the implementation of just the geographical elements of the WFD. The specification elements of the current GIS Guidance document (Vogt 2002) of this working group are listed in figure 5.

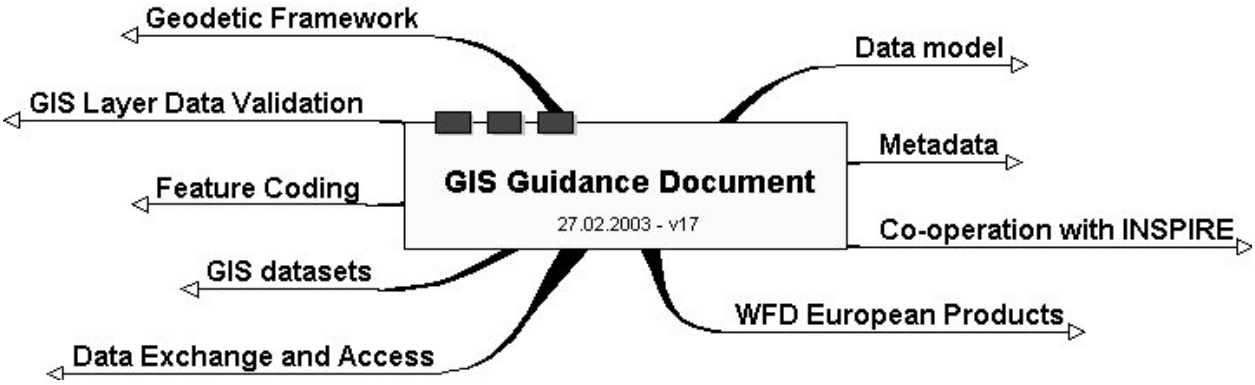


Figure 5: The elements of the GIS Guidance Document

The main proposal of the GIS working group is a stepwise WFD implementation approach by means of three different European WFD "products":

1. seamless data, e.g. harmonisation of geometric data (now)
2. centralised WFD database (1st phase, before the end of 2004)
3. federation of spatial WFD data servers (2nd phase, 2005-2006)

4. Conclusion

Looking at the specification gaps mentioned in the GIS Guidance document, there is an urgent need now to reflect the GIS element definitions with the needs of the sketched products. The result should be the specification of an IT Framework Architecture that

- is agreed and developed between IT users and IT vendor representatives.
- considers the stepwise approach from a centralised WFD database towards a system of federated WFD servers in the future,
- is compatible with the IT architectures INSPIRE - Infrastructure for Spatial Information in Europe <http://www.ec-gis.org/e-esdi/, 2003/02/27> and GMES – Global Monitoring for Environment and Security <http://gmes.jrc.it/, 2003/02/27>, and
- encompasses interfaces to other environmental topics (e.g. soil, land use).

The usefulness of the development and provision of WFD-specific tools for data acquisition, storage, exploration, visualisation, decision-support, spatial analyses, reporting, simulation & modelling should be discussed further on. As a key issue, the IT Framework Architecture should be validated in already identified pilot river basins in Europe before it is recommended as guidance to the EU member states and beyond.

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